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TECHNOLOGICAL TRANSFERS AND FOREIGN
MULTINATIONALS IN EMERGING MARKETS:
DEROSNE & CAIL IN THE 19th CENTURY

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Technological Transfers and Foreign Multinationals in Emerging Markets:
Derosne & Cail in the 19th c.

1. Introduction¹

This paper explores the relationship between foreign MNEs and the transfer of knowledge and technology in emerging markets. This crucial yet under-researched aspect of FDI is approached in two ways. First, through a review of the concepts proposed by the literature of international business, business groups and networks; and second, through a long term, empirical analysis of the operations of a prominent MNE in Cuba in the mid-19th century. We examine the transnational operations of the French firm Derosne & Cail', one the most innovative engineering firms in the mid nineteenth century as well as one of the first European companies supplying advanced sugar technology and railway equipment through an extensive network of factories, representatives, agents and branches across four Continents.

We use the tools and perspective of business and economic history to explain how multinational enterprises (MNEs) influence knowledge transfer between countries and boost economic growth, and how the process took place in an early period. The international business literature provides two different frameworks that shed some light on the subject. We do so in three different levels: 1) the international transfer of knowledge and technology between countries –and its success or failure-, 2) the MNE as a vehicle for this transfer, and 3) the mode of entry of a multinational *avant l'heure* like Derosne & Cail in a very competitive market as the Cuba sugar industry during the 19th century. Furthermore, the case- study could provide some clues in order to debate what we think we know on the first industrial revolution in some peripheral regions like the Caribbean.

At the international level, the contribution of international knowledge spillovers to endogenous socio-economic growth has been widely recognized: transfers from technological leaders provide positive effects on developing countries (particularly in regard to productivity gains), accelerating their modernization and catching-up processes.² But how is the transfer realized? The landmark work by Abramovitz (1986) pays attention to the concept of backwardness as an opportunity for catching up on

¹Acknowledgements: HAR 2012-35965/His, IT807-13 and FILT Project (ECO 2012-35266), UAM-CEMU2012-034 "Brand and its History: Economic, Business, and Social Value".

² See, among others, Romer, Paul M. "Endogenous technological change." *Journal of Political Economy* (1990), (98): 71-102; Grossman, Gene, and Elhanan Helpman, *Innovation and Growth in the Global Economy* (Cambridge, MA: MIT Press, 1991); Griliches, Zvi. "The search for R&D spillovers." *Scandinavian Journal of Economics* (1992), (94): 29-47; Coe, David T., and Elhanan Helpman, "International R&D Spillovers." *European Economic Review* (1995) (39): 859-887, Helpman, Elhanan, ed., *General Purpose Technologies and Economic Growth* (Cambridge, MA: MIT Press, 1998); Caniëls, Marjolein C. *Knowledge spillovers and Economic Growth. Regional Growth Differentials across Europe*, (Cheltenham: Edward Elgar, 2000); Keller, Wolfgang. "International Technology Diffusion." *Journal of Economic Literature* (2004), (42): 752-782; Lee, Gwanghoon. "The Effectiveness of International Knowledge Spillovers Channels." *European Economic Review* (2006) (50): 2075-2088; Hidalgo, Antonio, and José Molero. "Technology and industrialization at the take-off of the Spanish economy: new evidence based on patents." *World Patent Information* (2010) (32): 53-61.

technology, because undeveloped countries have the “social capability” to absorb more advanced technologies.³ Abramovitz adopts the concept of “social capability” to refer to those factors which inform of a country’s ability to appropriate technological and organizational change.⁴ He identifies them in terms of the extent of foreign technical competence to the local political, commercial and financial institutions. Yet another limitation to the absorption of technology from leading countries is represented by limited “technological congruence”, such as market size, stage of development and scale of production, in which new technology is generated and adopted.⁵

At the firm level, international business scholars have paid much attention to foreign direct investment (FDI) spillovers on host economies, emphasizing the role of MNEs in the transfer of technology and capabilities among countries.⁶ The increase of human capital has been one of the effects of FDI on the host country identified by economists. However, we know very little about how these capabilities are created or how FDI contributes to their formation in the local business community. Of course, our knowledge is even lower if we take into account the 19th Century.

As a way to transfer these capabilities, international business literature has paid a great deal of attention to the role of networks in order to overcome the liability of outsidership; e.g. the social capital theory.⁷ This concept, as embodied in the relationships between MNEs and local politicians and business elites in developing countries, was also applied to the study of FDI, MNEs and the ability to transfer capacities among countries.⁸ Recent literature on business groups has also paid attention to the relationships established by MNEs among local groups in protectionist, developing nations.⁹

³ Abramovitz, Moses. "Catching Up, Forging Ahead, and Falling Behind." *The Journal of Economic History* (1986) (46/2): 385-406; Barbiellini, Federico, John Cantwell, and Anna Spadavecchia.. *Innovation and Foreign Technology in Italy, 1861-2011*, (Roma: Banca d'Italia. 2011).

⁴ Ohkawa, Kazushi, and Henry Rosovsky, *Japanese Economic Growth*, (Stanford: Stanford University Press, 1973).

⁵ Abramovitz, Moses. "The Search for the Sources of Growth: Area of Ignorance, Old and New." *The Journal of Economic History* (1993) (53/2): 217-243; and "The Origins of the Postwar Catch-Up and Convergence Boom". In *The Dynamics of Technology, Trade and Growth*, eds. J. Fagerberg, B. Verspagen, N. Von Tunzelmann, 21-52. (Aldershot: Edward Elgar, 1994). Fagerberg, Jan., "Technology and International Differences in Growth Rates," *Journal of Economic Literature* (1994) (32/3): 1147-1175.

⁶ Kogut, Bruce, and Udo Zander.. "Knowledge of the Firm and the Evolutionary Theory of the Multinational Corporation". *Journal of International Business Studies* (1993) (24/4): 625–645.

⁷ Dunning, John H., and Sarianna M. Lundan. *Multinational Enterprises and the Global Economy*. (Cheltenham: Edward Elgar, 2008) ; Johanson, Jan, and Jan-Erik Vahlne.. "The Uppsala internationalization process model revisited: From liability of foreignness to liability of outsidership". *Journal of International Business Studies* (2009)(40/9): 1411–1431: 1414. Portes, Alejandro. "Social Capital: Its Origins and Applications in Modern Sociology". *Annual Review of Sociology* (1998) (24): 1-24.

⁸ Vernon, Raymond. *Sovereignty at bay: the multinational spread of U.S. enterprises*. (Longman, London, 1971).

⁹ Amsden, Alice H., and Takashi Hikino. "Project Execution Capability, Organizational Know-how and Conglomerate Corporate Growth in Late Industrialization." *Industrial & Corporate Change* (1994) (3/1): 111–147. Kock, Carl J., and Mauro F. Guillén. "Strategy and Structure in Developing Countries: Business Groups as an Evolutionary Response to Opportunities for Unrelated Diversification". *Industrial & Corporate Change* (2001) 10/1): 77–113. Guillén, Mauro F. *The Limits of Convergence: Globalization and Organizational Change in Argentina, South Korea, and Spain* (Princeton: Princeton University Press, 2010).

Informal networks have been mainly studied by Mark Casson.¹⁰ Networks facilitate the flow of information between the associates and reduce uncertainty in competitive environments. Especially in backward economies, to have the right contacts in order to overcome the obstacles of the imperfections of the market could be decisive. These networks have historically had relationships with foreign investors. The interaction between local networks and FDI is then useful when combining technology and foreign capital and local markets in protectionist economic environments.

The nineteenth century saw the industrialization of Western Europe driven by steam and coal. The impact of industrial technologies was, however, not limited to the European continent and had consequences on the other side of the Atlantic, on a group of colonized islands in the Gulf of Mexico. The industrial revolution would arrive in many peripheral regions through sugar production.

Between 1800 and 1880, a series of innovations decisively influenced the medium- and long-term economic growth of many of these Atlantic economies. Among the sectors that experienced rapid expansion during this period, sugar production doubtless underwent significant changes. This transformation was due in part to the increase in sugar consumption and therefore in demand. The general spread of sugar¹¹ accelerated as the standard of living rose along with the need for food with a high calorie content to withstand full time jobs in factories. World sugar demand and prices steadily increased into the 1820's, encouraging the cultivation of sugarcane in many regions across the globe,¹² multiplying the number of supplier and the competition between producers. Cuba was one of the countries that expanded its sugar cultivation, eventually becoming the leading producer of sugarcane worldwide.

However, as demand expanded, so did competitors and substitute products, such as sugar beet. The introduction of subsidized European beet sugar, the opening of the Suez Canal, technical advances and the considerable reduction in the cost of transport allowed sugar to become a globalized product. The need to deal with the international market characterized by large fluctuations¹³ that was continually welcoming new competitors, forced producers to cut costs and improve production in both quantitative and qualitative terms. Therefore, it is important to emphasize that the first industrial revolution was successful not only because of its globalizing effect but also because of the interconnection of networks (e.g., technological, financial, labor) and the competition that was generated in the first half of the nineteenth century between companies that relied on steam power. These companies, established in certain sectors such as the sugar industry,

¹⁰ Casson, Mark C. *Economics of International Business: A New Research Agenda*, (Cheltenham, Edward Elgar, 2000). Casson, Mark C., y Cox, Howard. "International business networks: theory and history", *Business and Economic History*, (1993) (22): 42-53.

¹¹ Sheryllynne Haggerty, «*Merely for Money*»? : *Business Culture in the British Atlantic, 1750-1815* (Liverpool: Liverpool University Press, 2012), 131.

¹² "Networks were retrenched at these times to those most trusted, reliable and reputable members of the trading community. Reputation mechanisms and fulfilling obligations were crucial to maintaining personal trust networks at such times". Sheryllynne Haggerty, «*Merely for Money*»? , 233.

¹³ Consumption per capita, kg/per year in 1890 England 33.3; USA 27.9; France 11.4; Suisse 10.7; Holland 9.9; Danemark 9.5; Germany 9.3; Belgium 9.1; Spain 3.7; Italie 3.6. Jean-Augustin Barral, *Dictionnaire d'agriculture : encyclopédie agricole complète. Tome III*, (Paris: Hachette et Cie, 1892), 719.

will planted the roots for what would become the multinational company of the end of the nineteenth century.

Sugarcane production became an advanced agro-industrial process that involved sugarcane cultivation (by free or forced labor) as well as industrial and chemical. Therefore, the technology used was decisive during this process. The uncertainty generated during periods of rapid technological development can generate some difficulties. Prior to 1850, two circuits or networks coincided: the one formed by the entrepreneurs/plantation owners needing access to the best available technology and financing, and the other that grouped the machinery manufacturers competing for. These two networks would originate curious marriage between technology (symbol of science and progress) and the slave labor/plantation system in some regions.

The Cuban sugar elite implemented, over the course of decades,¹⁴ a strategy that involved seizing control of colonial institutions¹⁵ to suppress hindrances to production and to facilitate the export of their products and the import of manufactured goods and machinery. A tacit agreement was reached between local authorities (legislation, institutional settings), local entrepreneurs (natural resources, labor force) and foreign entrepreneurs (technology, financial investments, skilled-workers) to establish the duty-free import of all material related to sugar mills¹⁶ and railway.¹⁷ To stimulate production and protect itself, this group also established a legal system of patents adapted to its needs. Over the course of the nineteenth century, techniques began to be superimposed, leading to the creation of mixed systems of mechanized, semi-mechanized and traditional sugar mills. The technologies used to process sugar were strictly defined in each phase (mills, clarification and boiling houses, refining). As in the textile sector, each new advance created a new obstruction, a bottleneck that had to be overcome.

Cuban plantations acquired the most cutting-edge sugar-producing technology worldwide. The first steam-powered machine used in sugar production was found in Cuba in the property of the Count of Jaruco and Mopox at his Ingenio [Mill] Ceibabo circa 1798; the railway was established a decade earlier than in Spain; and the first steam ship arrived in 1819. Gas lighting also appeared in 1819, and the first public demonstration of electric lighting was held in 1877.

Cuba is an interesting island because although it was a colony until 1898, its metropolis Spain, was incapable of providing technology, technicians, capital, or a market to the island. For these reasons the machinery had to be imported, Cuba was the ideal market for foreign manufacturers. Furthermore, metropolitan Spain did not impede the importation from these foreign machinery manufacturers, and even less did it represent a competitor. English and American manufacturers occupied a significant part of the

¹⁴ Antilles, Brazil, Java, Louisiane, Porto-Rico, Maurice, Réunion, Manille, Egypte, Mexico, China. For a critical review of recent studies on the origin and transformation of colonial sugar and slavery Cuba see Antonio Santamaría “Revisión crítica de los estudios recientes sobre el origen y la transformación de la cuba colonial azucarera y esclavista”, in *Am. Lat. Hist. Econ.*, (2014) (21/ 2):168-198.

¹⁵ Prices fluctuated downward between 1820 and 1854, with a slight recovery in the 50's but prices never reached again those of the early nineteenth century.

¹⁶ See Imilcy Balboa, *De los dominios del rey al imperio de la propiedad privada. Estructura y tenencia de la tierra en Cuba (siglos XVI-XIX)*, (Madrid: CSIC, 2013) and Franklin Knight, “Origines of the Weath - and the Sugar Revolution in Cuba”, *Hispanic American Historical Review*, (1977) (57/ 2): 231-253.

¹⁷ Nadia Fernández-de-Pinedo, Patricio Saiz, David Pretel, «Patent, Sugar Technology and Sub-Imperial Institutions in Nineteenth Century Cuba», *History of Technology* 30 (2011) (30): 46-62.

machinery market related to steam power and sugar refining. The British had an enormous advantage because of their access to raw material, technical knowledge and the already advanced British sugar-refining industry. The Americans had an advantage in their rapid industrialization and the consequent multiplication of foundries associated with the industry, its plantations and sugar refineries. However, France was also making inroads in this competitive sector. Cuba was a perfect market for selling machinery and tools.

We present here a rather exceptional case- study that expects to integrate both frameworks (firm and international levels) through the experience of an MNE *avant l'heure* (Derosne & Cail) in a colonial country (Cuba) with an open exporter economy in the 19th century. We will focus specially on one of its branches: sugar machinery, taking into account that this firm was one of the world main developers, producers and sellers of sugar technology in the nineteenth century. The transfer of technical innovations was probably its main goal. ‘Derosne and Cail’ followed a global strategy from its beginning in 1812 using foreign agents and offices, the management of intellectual property rights and encouraging the relationship of the firm with local elites and professionals “Our case study will demonstrate an early experience (much earlier than the proliferation of MNEs) of an astute successfully global strategy of diversification and internationalization, effectively harnessing an extensive international network of intermediaries that turned this company in one of the first European multinationals.

The structure of this paper is as follows. The first section highlights the main turning points of the company. The second provides the clues to understand its advantages in the Cuban market. Finally, we assert some conclusions.

2. Derosne & Cail: an emerging leader in sugar-machinery production

2.1. The Company

Derosne & Cail is an example of the large mechanical companies born during the early year of the Industrial Revolution. It was established by entrepreneurs from northern France trained in a context of practical and applied science. Its strategy included diversification, internationalization and creating brand value.

Charles Derosne (1780-1846) was a chemist by profession -his father founded the pharmacy Derosne & Cadet¹⁸- and became a member of the Academy of Medicine in 1823. Charles established the *Maison Derosne* in 1812¹⁹ in Paris, where the headquarters of the firm would later be located, and in 1814 founded the *Derosne & Cie*²⁰ corporation in Chaillot. His training made his apparatus for continuous distillation, an improvement on Cellier-Blumenthal’s system of continuous distillation,²¹ famous in the Midi

¹⁸ The railroad arrived ten years before in the colony than into its metropolis in order to support the production and exportation of sugar cane.

¹⁹ Charles Louis Cadet de Gassicourt was Napoleon’s pharmacist.

²⁰ The origin of the factory, was the Dyes Factory created by Chaptal.

²¹Refines and implements the system along with the inventor himself, Mr. M. Cellier-Blumenthal.

vineyards. The manufacture of stills for distilling grapes, potatoes and seeds became an important part of his business. In fact, he specialized in the manufacture and sale of the *Champonnais*²² system, which allowed farmers to distill their beets and other plants themselves.²³

After developing distillation apparatuses, Derosne began to manufacture machinery for the French refinery industry. Charles Derosne wrote the preface to Angar's German translation of Achard's *Traité complet sur le sucre européen de betteraves*, which detailed how to extract sugar from sugar beets. During the continental blockade, Derosne, encouraged by Napoleón I's subsidization of sugar beets to no longer depend on imports of sugar cane, began to broaden his business and market in Europe and the Antilles in 1815.²⁴ Galloway in the *Sugar Cane Industry* notes that Derosne & Cail was the first sugar beet machinery company "that tried to reorganize the cane industry as a means of opening up a huge market for its equipment, suitably adapted to cane."²⁵

Its first internationally recognized successes were those obtained in the area of chemistry, a sector in which the company was certainly proactive.²⁶ Between 1804 and 1812, it conducted sugar-bleaching experiments using syrup; in 1813, the company introduced the use of bone-black or bone-charcoal, tested in the refinery of M. A. Sainterre.²⁷

Derosne had, with engineer Degrand²⁸, studied Horward's double-effect evaporation apparatus.²⁹ He used his knowledge of this equipment to create a double and triple effect evaporation apparatus for sugar refining for which he obtained a patent in 1835. This apparatus gave him an unrivaled reputation in the sugar sector because, among other advantages, it reduced by 2/3 the amount of charcoal consumed in sugar refineries. In 1828, Derosne was granted a 15-year French patent and several additional patents for adjustments made to sugar-refining machinery he had manufactured.³⁰ Obtaining exclusive rights to its exploitation in 1834 led to various lawsuits with Degrand³¹ over the system's authorship.

The other founding member of the company was Jean-François Cail (1804-1871), a boilermaker who had begun work as a laborer in 1824 at Derosne & Cie. After becoming

²² Champonnois in 1834 obtained a patent for 5 years, for new evaporation apparatus whose principle has already been described in Derosne's patent.

²³ Champonnais and Derosne agreed to manufacture the apparatus together. Armengaud Ainé, *Publication Industrielle des machines, outils et appareils les plus perfectionnés et les plus récents employés dans les différentes branches de l'Industrie française et étrangère* (3rd. ed., Paris, 1862), 42.

²⁴ E. Chadeau, *L'économie du risque. Les entrepreneurs 1850-1980* (Paris, ed. Oliver Orban, 1998), 25.

²⁵ J. H. Galloway, *The Sugar Cane Industry: An Historical Geography from Its Origins to 1914* (Cambridge: Cambridge University Press, 2005), 157.

²⁶ He is the first person in creating in 1811 the "allumettes phosphoriques à frictions". Léopold Gautier & Rudolf von Wagner, *Nouveau traité de chimie industrielle à l'usage des chimistes* (Paris: F. Savy, 1879), 509.

²⁷ Derosne had a lawsuit with Wetzell, whom he accused of having usurped his clarification system with animal bone-black. Jean-François Géraud, «Joseph Martial Wetzell (1793-1857): une révolution sucrière oubliée à La Réunion», *Les Mascareignes et la France, Revue Historique des Mascareignes*, (1998) (1): 113-156.

²⁸ E. Degrand, french civil engineer, designed the double-effect evaporator that was manufactured by the firm of Derosne and Cail and installed in Louisiana, Cuba, among other countries.

²⁹ Howard, like Roth, or Pelletan and Baivet invented the boilers vacuum pan.

³⁰ Armengaud Ainé, *Publication Industrielle des machines, outils et appareils*, 40.

³¹ Degrand and Derosne went to court for the authorship of that system.

an apprentice and then a foreman, he rapidly became chief of the workshop, finally becoming a partner in 1830. In March 1836, the firm Derosne & Cail was established. Cail was responsible for perfecting Derosne's double-effect evaporation system, again achieving a notable reduction in the consumption of charcoal.

Once they became partners, the company grew, creating branches, associating with other professionals, internationalizing and diversifying production.

In neighboring Brussels, the company founded, through their association with the mechanic Alexandre Halot, the *J.F. Cail, Halot & Cie*³² branch in 1833/36. This branch enabled them to distribute steam equipment to industries and sugar processors in northern Europe. The best way to offer competitive prices was to conduct business from Belgium, where raw materials, iron and coal were more accessible. Alexandre Halot left the Indret workshops to direct the French branch.³³

To take advantage of the synergies they established in the French territory, the company opened a location in Chaillot, a large factory for the construction of motion machines. In this factory, they began to specialize in the construction of steam machinery and metal bridges. In 1844, they started manufacturing locomotives; their first order was a lot of 8 "locomotives pour voyageurs" commissioned by *Chemin de Fer du Nord*.³⁴ The company grew from 50 workers to 700.³⁵ The Chaillot factory specialized in the assembly of locomotives and mechanical work and was soon able to assemble 25 locomotives simultaneously. Two years later, Derosne & Cail obtained a contract to construct 22 locomotives using plans developed by Stephenson.³⁶ Also asked to construct the locomotives destined for the Lyon-Paris line, they manufactured a total of 67 locomotives by 1848.³⁷ However, the latter locomotives were constructed according to plans developed by M.A. Barrault, not by Stephenson.³⁸ In 1846, after the death of Derosne,³⁹ Cail acquired engineer T. R. Crampton's French patent in exclusivity for 15 years. As a result, the new company, *Cail & Cie*,⁴⁰ was able to supply the express lines in northern and eastern France, the Lyon line and the Boulogne-Marseille line with Crampton locomotives, fully transitioning into the railway business. They grew from making 12 locomotives in 1851 to 176 two years later. Business boomed; they had purchased the

³² Elie Delinières started working in Cail & Co. in 1849, and soon after was sent to Brussels in charge of the construction workshops. Ernest Rocher (1837-1907), will be transferred from the headquarters in Paris to Cail-Halot as a draftsman and will quickly become engineer in chief until 1891.

³³ Turgan, *Les grandes usines, études industrielles en France et à l'étranger*, vol. 2 (Paris: Michel Lévy frères, 1865), 18.

³⁴ Turgan, *Les grandes usines, études industrielles en France et à l'étranger*, 17.

³⁵ He had a good relationship with them: handing out profits with them, health insurance covering factory and home ...

³⁶ Locomotives in France were built according to plans by Stephenson until 1845-1846, thereafter the improvements introduced by Al M. Barrault were considered. Chatelier, MM.I.; Flach, E.; Petiet, J. et Polonceau, C., *Guide du mécanicien constructeur et conducteur of locomotives machines*, (Paris: Chez Paul Dupont ed., 1851), 370.

³⁷ Chadeau (1998), 27.

³⁸ Chatelier, MM.I.; Flach, E.; Petiet, J. et Polonceau *Guide du mécanicien constructeur et conducteur of locomotives machines*: 19-20.

³⁹ Although Derosne died in 1846, the company name *Derosne & Cail* continued until 1848. J. F. Cail et Cheilus formed under the same company name a company with new capital.

⁴⁰ French law requires him to become Limited Company and he went on to become a limited company in 1846 to 1848 with a capital of 7 million francs and J.F. Cail forward as manager of the firm.

patent from Crampton for 2500 francs, and each locomotive was selling for 58,000 francs. The company expanded to taking orders for railways in Russia, Spain,⁴¹ Italy, Switzerland and Egypt. The company's diversification of production coincided with the peak, during the Second Empire, of French-manufactured locomotives. Derosne & Cail became one of the five largest locomotive companies in France, along with Schneider, Graffenstaden, the Société des Batignolles and Fives-Lille.

In addition to being involved in the sugar industry, distillation, steam and locomotives, in 1845, the company also began manufacturing Thonnellier's currency presses for the *Hôtels des Monnaies* or Royal Minting in France and similar institutions abroad.⁴² During the Franco-Prussian War, the company joined other French companies in manufacturing armaments for the government, a business they continued after the war.⁴³

Given the high demand for the company's products, it was necessary to increase the number of factories before 1850's. The firm therefore established a factory in Grenelle (Paris) and created additional subsidiaries. The Grenelle factory specialized in steel and copper boilers because a forge had already been installed to make steel bridges and viaducts for the extension of the Russian railways. The company also established an *atelier* or workshop for boilers, steel and forges in Denain (1844), to which two subsidiary plants were added, one in Douai and the other in Valenciennes (directed by Frédéric Zoude). To manage these operations, the *Société Jacques et Jean François Cail et Cie* was created, headed by Cail's elder brother Jacques Cail.⁴⁴ This company was distinct from *J.F. Cail et Cie* of Paris, which was doing business as J.F. Cail et Cheilus⁴⁵ and through the Grenelle subsidiary. In reality, however, the companies were closely associated: the wheels, boilers and tenders of the locomotives were made in Denain and were then brought to Paris to be adjusted and completed.⁴⁶

From the headquarters in Brussels (Molenbeeck), the company expanded to Amsterdam (1846), where it joined two renowned builders of ships and naval machinery to create *Van Vlissingen, Van Heel & Derosne, Cail et C^a*. This company specialized in building refinery and distillation machinery that could be shipped to the Dutch colonies (Java).

⁴¹ Locomotives for the Railroad Company of Madrid, Zaragoza and Alicante. The construction of the Ciudad Real, Badajoz and Belmez Almorchon-line and numerous bridges in Albacete-Cartagena, Córdoba-Cádiz, or the Palma bridge over the Guadalquivir River ...

⁴² Providing 36 to the Mint of Paris, 64 to the mints in provinces and abroad in Russia, Italy, Switzerland, Belgium, Spain, Portugal, Austria, Persia, Egypt, China, Chile, Venezuela, Argentina R. Gentilini, "Exposition Universelle of 1889", *Le Génie civil. Revue générale des industries françaises et étrangères*, (Paris: Imprimerie Centrale des Chemins de Fer, 1880), 107.

⁴³ In the course of the taking of Paris during the Franco-Prussian War the company had to manufacture artillery material for the first time. However, in less than four months the company was able to fill 67 machine guns (Christophe and Gatling), 100 cannons, flame-throwers, howitzers... In 1882 *La Société des anciens établissements Cail* still providing the Navy and the Department of War with cannons and artillery equipment.

⁴⁴ At his death, the company is dissolved and the ateliers of Denain, Douai and Valenciennes will be integrated into one, the Régie de Denain, under the direction of the two former directors of Douai and Valenciennes.

⁴⁵ Cheylus went to work for Charles Derosne in 1832 to deal with the administrative side and then turned in one of the managers of *J.-F Cail et Cie*.

⁴⁶ «Travaux de chaudronnerie et de forge par MM. Jacques et J.-F. Cail, à Denain», *Le Génie industriel : revue des inventions françaises et étrangères : annales des progrès de l'industrie agricole et manufacturière* 10 (Paris, Imprimerie Centrale des Chemins de Fer, 1855), 309.

The king of the Netherlands had granted them a fifteen-year exclusive right to supply the country with all of the machinery used in the sugar production in the colonies.⁴⁷ They had already started in 1840, when Derosne & Cail provided machinery to the Javanese plantations of M. Lucassen, Chevalier Hollenberg, Stevers, Kempenaar, J.J. von Braam, and Pretorius and Cie, among others.⁴⁸ The first complete factory installation in Java that used a Derosne & Cail vacuum pan was in fact completed in 1842.⁴⁹

Just as it had done in continental Europe, the company extended its network throughout the sugar-producing islands by establishing branches and agents in Cuba, Guadalupe, Martinique, Mauritius, Java and Bourbon before 1850.⁵⁰ Indeed, if the company knew how to sell anything it was the idea of industrial progress and modernity through technology.⁵¹

As early as 1826, it tried to establish on Guadalupe by sending two chemists (Plaigne and Legras) but did not meet with success until they began to build their first *sugar centrales*⁵² in 1844-1845 and sent technicians. Jean-Baptiste Monnier, originally employed by Derosne & Cail in Paris, was initially assigned to directing the construction of the centrales in Guadalupe and in 1845 was further entrusted with installing the first sugar plant in the Nile valley under a contract from the Viceroy of Egypt.⁵³ In 1838, Derosne & Cail began to propose the creation of central factories⁵⁴ for treating sugarcane using the sugar beet method. The firm aspired to improve the situation in the French sugar colonies, which were in decline in part because of France's sugar policy and the backwardness of the island refineries. This idea was well received and was discussed by P. Daubrée in his 1841 book *Questions Coloniales sous el rapport industriel*.⁵⁵ However, it would not be until 1863 when, with the aid of the *Société de Crédit Foncier Colonial*,

⁴⁷ "dépuration des sucres dans les colonies". Gustave Vapereau, *Dictionnaire universel des contemporains, contenant toutes les personnes notables de la France et des pays étrangers... ouvrage rédigé et continuellement tenu à jour, avec le concours d'écrivains et de savants de tous les pays* (Paris: L. Hachette, 1865), 308.

⁴⁸ J.A. Leon, *The sugar question. On the cultivation in the West Indies* (London, John Ollivier, 1848), 12.

⁴⁹ Ulbe Bosma, *The Sugar Plantation in India and Indonesia: Industrial Production, 1770-2010* (Cambridge: Cambridge University Press, 2013), 107.

⁵⁰ Chadeau (1988): 28-29.

⁵¹ David Pretel, Nadia Fernandez-de-Pinedo "Circuits of knowledge: foreign technology and transnational expertise in nineteenth-century Cuba" in Leonard, A. & Pretel D. (eds), *The Caribbean and the Atlantic World economy: circuits of trade, money and knowledge, 1650-1914* (London: Palgrave-McMillan 2015).

⁵² A Central is a complex and modern system of sugar production that was devised in the 40s. The Central could be of two types: or companies that pooled the cultivation and manufacture, or a system in which there was no such integration and on the other hand where production was separated from the crop that was performed through small business, with planters....

⁵³ www.patronsdefrance.fr (Seen the 22th of February 2014).

⁵⁴ Derosne was the architect of the Central to boost the sugar beet industry in France. This system is based on the division of labor: 1) separates agricultural work, the cultivation of sugarcane, from the manufacturing jobs; 2) build Centrals with European capital and leading machinery to processed raw cane, selling the final product in the metropolis. This system was first adopted in Europe in the sugar beet production and then in the colonies to be used with sugarcane. The transfer of technology now, was from the beet to the cane. A. F. Laine, *Mémorial du commerce du commerce et de l'industrie, universel this folder, théorique et pratique, législatif et Judicaire, commerciale of science*, vol. 8 (Paris: Bureau du Mémorial du commerce, 1844), 382.

⁵⁵ Frédéric Barbier, Pierre Deyon et al, *Le patronat du Nord sous le Second Empire: une approche prosopographique* (Genève : Droz, 1989), 135.

such factories would appear in Guadeloupe.⁵⁶ Cail also decided to partner with Ernest Souques, and together they founded the *Compagnie Sucrière de la Pointe-à-Pitre* in 1867. Cail provided the capital: 2,400,000 francs.⁵⁷ This was not the only company for which he provided capital; he also furnished capital for the *Antilles Société des Usines Centrales* (Guadeloupe). It was also not the only company controlled directly by Cail & Cie. After constructing the factory at Bibeh in Egypt, Cail appointed engineer Albert Vanier as the director of the *Zevallos au Moule* manufactories in Guadeloupe, a position that he held between 1877 and 1886.⁵⁸

The same strategy was used on Martinique, where on several plantations at Pointe Simon, including those of Guillot and Quenesson, Derosne & Cail installed machinery in 1845. The most profitable experiment, however, was conducted in the Indian Ocean on Réunion, formerly known as Bourbon, where plantation owner A. Auguste Vincent installed a Derosne & Cail apparatus at his *St. Marie* mill in 1838. In his treatise *The sugar question*, J. A. Leon reported that the landowner obtained 50 to 60% more sugar.⁵⁹ Appreciative of these results, Vincent built a new and modern central plant in 1841, apparently with similar success. The results prompted other plantation owners to imitate him, including Chabrier, Henry Sicre, Vincent, Godard, Roustnat and Co., and Desbassayns. There could be no better advertising for the French company. They eventually established an agency on the island in 1852 that enjoyed a good reputation. Indeed, the business increased its first-year earnings of 50,000 francs to 1,500,000 francs in 1857.⁶⁰ Because of the demand for its machinery in Java and Réunion, Cail & Cie built warehouses for its products on Mauritius, located between the two islands.

The 1840s were a period of consolidation and success for the French company. In 1845, the number of sugar beet establishments that had installed Derosne & Cail equipment increased to 45 in France, Austria, Belgium and Russia. These establishments reported an annual output of 10,310,000 kilograms⁶¹. The number of sugarcane factories using the company's equipment was 32. These were located in French colonies, Java, Cuba, Mexico, Rio de Janeiro and Egypt (those in Egypt were under contract⁶²) and had an annual production of 31,200,000 kilograms.

Its international network of contacts and the reputation it earned through the good performance of its factories gave the company an advantage in the openly competitive Atlantic and Asiatic markets. However, as industrialization continued its inevitable spread throughout most of Europe, machinery making companies began increasing in number. Therefore, the need to design and perfect its heretofore-successful strategy became a necessity. This new plan led J.F. Cail, in the 1850's and 1860s, to adopt two clear strategies. One had already been tried in a more modest way: cooperation with

⁵⁶ M. Guicharnaud-Tollis, "L'équipage Derosne en Guadeloupe et Cuba au XIX^{ème} siècle: stratégie commerciale française et réticences créoles", in Michèle Guicharnaud-Yollis (ed.), *Le sucre dans l'espace caraïbe hispanophone, XIX et XX^{ème} siècle*, (Paris: L'Harmattan, 1998): 128.

⁵⁷ Cr. Schnakenbourg, *La Compagnie sucrière de La Pointe-à-Pitre (E. Souques & Cie), histoire de l'usine Darhoussier de 1867 à 1907* (Paris: L'Harmattan, 1997).

⁵⁸ www.patronsdefrance.fr (Seen the 22th february, 2014).

⁵⁹ *The sugar question by an European and colonial sugar manufacturer*, Part II, (London, 1848), 13.

⁶⁰ Turgan, *Les grandes usines, études industrielles en France et à l'étranger*, 23.

⁶¹ Tripiar, *Empresa azucarera peninsular con privilegio exclusivo [sic] de introducción*, 8.

⁶² *Bulletin de la Société d'études des Hautes-Alpes* (Gap: Société d'études des Hautes-Alpes, 1981), 14.

competitors. They had collaborated from its beginning with other inventors to manufacture their machines (e.g., Champonnais). To execute this strategy on a larger scale, they joined *Parent-Schaken and Cie de Lille*, the future Fives-Lille, and acquired stock in the steel mills of Denain-Anzin. These steps allowed them to share orders and costs, especially when they moved into metal construction.⁶³ In the 1870s, the company expanded to South America. The first central plants were built in Bahía, Brazil. These refineries were installed with machinery manufactured by *Derosne & Cail and Fives-Lille*,⁶⁴ a pattern followed in Trinidad, Montevideo, and Puerto Rico.⁶⁵ The second strategy was to find new markets; the French railway market had become saturated. The company continued supplying locomotives to France, but found new markets in Spain, Switzerland, Egypt and Russia.⁶⁶ The search for new opportunities beyond Europe led them to Russia, where in 1852, after providing a set of steel bridges and viaducts for the Moscow-Nizhny-Novgorod and Moscow-Saratov lines,⁶⁷ they placed a permanent agent and installed a machinery warehouse in Smela (Kiev). Another warehouse was established in Moscow, and a complete factory was built in St. Petersburg. The branch in Brussels and the headquarters in Paris shared the warehouses in Smela and Moscow, but the factory in St. Petersburg was built by the Paris company. In 1863, they performed a maintenance of the rolling stock for the Nicolas railway, and between 1866 and 1871, they worked with the *Société de Vrière, Schaken, Bruneau et Cie* to manufacture all of the material for the Kiev-Balta railroad, which was more than 600 kilometers long.⁶⁸

In all of the agencies abroad and in the colonies, an engineer oversaw the technical work and an administrative agent was responsible for the commercial and financial side of the operations. The agencies sold and repaired the machinery. The headquarters in Paris provided the plans for the machinery, maintained contacts, and controlled each agency and subsidiary, which would periodically send accounting books and inventories. Centralization and control of the company was absolute.⁶⁹

Each subsidiary or agency would periodically send a copy of its ¹ “diary book, its cash book and its inputs and outputs book store. The headquarters of Paris, on these important documents, keeps in his office accounting, accounting detail and double accounting. An inventory made at the beginning gave a starting point for agreement, and periodic, annual and semi-annual inventories help to maintain consistency. For branches and annexes whose topography allows prompt and frequent communication, shipments entries are made only quarterly, the agencies that are placed abroad are sending the information

⁶³ Jeanne Gaillard, “Les usines Cail et les ouvriers métallurgistes de Grenelle”, *Le Mouvement Social*, (1960) (33/34): 35.

⁶⁴ Agents diplomatiques, *Bulletin consulaire français*, 1880, 105.

⁶⁵ Agents diplomatiques, *Bulletin consulaire français: recueil des rapports commerciaux adressés au Ministère des affaires étrangères par les agents diplomatiques de France à l'étranger* (Paris: Imprimerie nationale, 1880), 522-523.

⁶⁶ Turgan, *Les grandes usines, études industrielles en France et à l'étranger*, 17.

⁶⁷ Turgan, *Les grandes usines, études industrielles en France et à l'étranger*, 20.

⁶⁸ Gentilini, *Exposition Universelle de 1889*, 103.

⁶⁹ Turgan, *Les grandes usines, études industrielles en France et à l'étranger*, 2.

monthly”.⁷⁰ The central plant had a “sort of photographic reproduction of their daily life”.⁷¹

In 1883, the Société J.-F. Cail & Cie, which had in 1870 been joined by another of Cail’s sons, Alfred Cail, who acted as a manager, was replaced by the *Société Anonyme des Anciens Établissements Cail*⁷² until it was supplanted in 1898 by the *Société française de constructions mécaniques*,⁷³ which merged with Fives-Lille in 1958.

2.2. Cail & Cie and Fives-Lille

This section returns to the phase in which the company joined the Belgian engineers *Parent & Schaken*. Beginning in the 1860s, *Cail & Cie* and *Fives-Lille* began to follow parallel paths that occasionally intersected. A century later, after several fruitless attempts, the two companies finally merged many years later, in 1958, to form *Fives-Lille-Cail*.

Basil Parent had worked on the construction of the first railway in his native land. Pierre Schaken, also an engineer by training, had begun his professional career in the army. They met during Belgium’s war of independence and began their joint professional ventures. Both engineers would be entrusted with the production of railways and locomotives by the *Compagnie du Chemin de fer du Grand Central*. Unlike *Cail & Cie*, Fives-Lille was a company established in the second half of the nineteenth century (1861) as *Ateliers de construction mécaniques* under the corporate name *Parent, Schaken, Caillet et Cie*. It was created to manufacture steam locomotives, civil machinery, and railway rolling stock and had workshops in the city of Lille’s Five neighborhood and in Givors (Rhône). Four years later, in 1865, the *Compagnie de Fives-Lille* was created, which later became the *S.A. Compagnie de Fives-Lille pour constructions mécaniques et entreprises*. In November 1861, as mentioned above, this company merged with *Cail & Cie* to form the “*participation J.F. Cail, Parent, Schaken, Houel, Caillet, Paris et Fives-Lille*”. According to the available consular information, some of the machinery that both companies manufactured for export to America was shipped from Antwerp, making it a Belgian rather than French import.⁷⁴

⁷⁰ Translate from french: “livre journal, de son livre de caisse et de son livre d’entrées et sorties de magasin; la maison de Paris, sur ces documents primordiaux, tient à son bureau de comptabilité, sur des errements tracés à l’avance, une comptabilité de détail et double avec celle que tient elle-même la maison dérivée. Un inventaire fait au debut a donné un point de départ d’accord, et les inventaires périodiques, semestriels et annuels permettent d’entretenir la concordance. Pour les maisons sucursales et annexes dont la situation topographique permet des communications promptes et fréquentes, les envois des écritures ne se font que trimestriellement, les agences placées à l’étranger, font ces envoies mensuellement.” Turgan, *Les grandes usines, études industrielles en France et à l’étranger*, 64.

⁷¹ “sorte de reproduction photographique de leur existence journalière”

⁷² They reach China, Senegal, Venezuela, Grecia, Serbia, Suecia, Costa Rica, Dinamarca, Mejico.

⁷³ Jean-Adolphe Decourdemanche, «Société française de constructions mécaniques (Anciens établissements Cail)», in *Manuel des valeurs cotées hors parquet à la Bourse de Paris* (Paris: E. Desfossés et Fabre frères, 1900), 286-288.

⁷⁴ Agents diplomatiques, *Bulletin consulaire français: recueil des rapports commerciaux adressés au Ministère des affaires étrangères par les agents diplomatiques de France à l’étranger*, vol. 17 (Paris: Imprimerie nationale, 1889), 571.

This collaboration was more favorable to *Fives-Lille* than to *Cail & Cie*, which already had a positive and established reputation. The partnership not only allowed *Fives-Lille* to collaborate in the construction of frameworks, bridges, viaducts and locomotives but also introduced them to a sector previously reserved for *Cail & Cie*: the sugar industry. When the partnership dissolved in 1870, the *S.A. Compagnie de Fives-Lille pour constructions mécaniques et entreprises* became *Cail & Cie*'s principal French competitor in the sugar sector, in which the two companies operated in parallel. Beginning in 1870, equipment manufactured by *Fives-Lille* appeared in all of the sugar markets in which *Cail & Cie* had established a presence; *Fives-Lille* followed the path already opened by its former collaborator.

This example demonstrates that, in sectors reliant on machinery and steam power, the cost of entering other industrial markets was low because all of the apparatus shared the same basic principles. *Fives-Lille* "vampirized" the knowledge it acquired and most likely exploited the networks it developed through its collaboration with *Cail & Cie*. Using these resources, it also became a manufacturer of sugar machinery. Indeed, there was a constant movement of engineers and mechanics from one company to the other. Edmond Beaudet, chief of workshop at *Cail & Cie*, left to work at *Fives-Lille*, becoming director of research and later sub-director of the firm's workshops.⁷⁵ François Berry, trained as "ouvrier ajuster" at *Fives-Lille*, later became a designer at the *Établissements Cail*. Alfred Bougault, engineer and head of services at *Fives-Lille*, eventually became the general director of the *Société Cail* in the 1880s before being named general delegate of the company's administrative council.

Although competitors, these two companies, accompanied by *Decauville* beginning in 1875, constituted a French presence that competed with British manufacturers for the English markets in Asia and America,⁷⁶ indicating that French industry prior to 1880 was highly competitive, despite not benefiting from the advantages that the British enjoyed such as access to inexpensive raw materials and economies of scale in the metallurgical sector.⁷⁷

Fives-Lille and *Cail & Cie* finally merged in 1958, forming the *Société Fives-Lille Cail*. This merger was the first of many, and the new company eventually absorbed *Applevage* (1963) and *Bréguet* and *Bréguet-Sauter-Harlé* (1966) before merging with *Babcock-Atlantique* (1973). The resulting company, *Fives-Cail-Babcock*, dominated the market for heavy machinery in France in the 1970's. In the 1980s, it became a true holding company, maintaining its policy of mergers and absorptions (1987: *Stein Heurtey, Nordon, Pillar*; 1997: *Cinetic*).⁷⁸ In 2007, it consolidated its identity into a single commercial trademark: *Fives*.

⁷⁵ www.patrondefracne.fr (Seen the 22th february 2014).

⁷⁶ "Les fabricants anglais, qui autrefois passaient pour être seuls en mesure de fournir les appareils de sucrerie, ont vu baisser considérablement, dans ces dernières années, le chiffre de leurs affaires. Ce sont les usines de Fives-Lille et de Cail et Cie qui les supplantent maintenant presque partout, tant pour la transformation de l'outillage ancien que pour la fourniture du matériel nécessaire à l'installation des nouvelles fabriques qui s'élèvent de toutes parts". Agents diplomatiques, *Bulletin consulaire français : recueil des rapports commerciaux adressés au Ministère des affaires étrangères par les agents diplomatiques de France à l'étranger* (Paris: Imprimerie nationale, 1882), 861.

⁷⁷ Noël Regnier, *L'industrie française au XIXe siècle* (Paris: L. Sault, 1878), 319.

⁷⁸ Centre des Archives du Monde du Travail, Fives-Lille 1991 005; Fives-Cail-Babcock FCB 1994016.

3. The company's advantages

Eduardo Rodríguez, industrial engineer and Phd in Sciences, detailing the advances showcased at the Universal Exposition of London in 1862, noted that *Cail* of Paris was celebrated for “the variety of its products and the extensiveness of its manufacturing, found at present in the various workshops in different countries where more than 4,500 workers are located: material for railroads, steam engines, bridges, hydraulic motors, presses, apparatus for distillation and evaporation and many others, as well as the useful tools for many industries that are made by this company.”⁷⁹ This section will analyze the business and commercial strategy that this company followed in one of its sectors, sugar refining in Cuba in mid-nineteenth century. The strategy established by the headquarters wove a solid network based on the good reputation derived from “*la supériorité du système de ces installations et de leur construction*” and the company's ability to meet demand at prices superior to those of its English and American competitors. These advantages assured the company an average volume of trade in Cuba valued at between 1,500,000 and 2,000,000 francs annually (300.000/400.000 \$).⁸⁰

3.2. Two problems: an expensive machinery and competition in nineteenth century

3.2.1. Price

All of the sources related to the firm's sugar machinery show that it was expensive equipment. Paul Daubrée, in *Question Coloniale sous le rapport industriel*, summarized the pros and cons of the company's apparatus. He states that the advantages of the *appareil à cuire dans le vide* were incontestable due to the amount of fuel saved, the ability to induce evaporation at low temperatures and the resulting increase in the quality of sugar production. However, there were several disadvantages: the extreme “*délicatesse de l'appareil*” that required “*hommes spéciaux*” during the boiling process and the equipment's “*cherté de premier achat*” and “*cherté d'installation*”.⁸¹ To sum up: expensive machinery that required skilled workers.

The French consul in Santiago de Cuba stated that many central factories had been built in nineteenth century with equipment from *Cail* and *Fives-Lille* with positive results but that they cost between 500,000 and 600,000 francs⁸² (100,000/120,000\$). Furthermore, payment had to be made in a short time.⁸³ In 1846, seven sugar mills existed in Java that

⁷⁹ Eduardo Rodríguez, *Estudio de los objetos que en la exposición de Londres del año 1862 tenían relación con las aplicaciones de las ciencias físicas* (Madrid: Imprenta Nacional, 1865), 55.

⁸⁰ Turgan, *Les grandes usines, études industrielles en France et à l'étranger*, 22.

⁸¹ M. Paul Daubrée, *Question coloniale sous le rapport industriel* (Paris: Impr. De Malteste et C., 1841), 76.

⁸² According to Roland T. Ely a French Franc equal to 0.20 \$ until the First World War. Roland T. Ely, *Cuando reinaba su majestad el azúcar: Estudio histórico-sociológico de una tragedia latinoamericana, el monocultivo en Cuba: Origen evolución del proceso* (Madrid: Imagen Contemporánea, 2001), 537, note 73.

⁸³ Agents diplomatiques, *Bulletin consulaire français: recueil des rapports commerciaux adressés au Ministère des affaires étrangères par les agents diplomatiques de France à l'étranger* (Paris: Imprimerie nationale, 1886), 115.

functioned according to the Derosne & Cail method, and the installation of each of these had cost approximately 300,000 florins (525,000 francs), which had been paid by the Dutch government.⁸⁴ The price was the same in Dutch Guyana: approximately 500,000 francs (100,000\$)⁸⁵. In Java, once the fifteen-year exclusive contract granted by the Dutch government expired, the sugar makers, according to the French consul Garnier, began to buy English, Belgian, and German machines of inferior quality but cheaper. Although he believed that they were more expensive in the long term because of the repairs necessary after one year of use, they were half as expensive as the French equipment.⁸⁶ However, by 1870, most of the steam machines formerly supplied by England began to be supplied once more by the French companies *Cail* and *Fives-Lille*, who had sent company representatives to Java. These circumstances indicate the second obstacle that the company had to face.

3.1.2. Competition

As has been noted, as the century progressed, the Germans and Belgians began to enter the markets. In Southeast Asia, the competition from German companies began to be felt in the 1870s, despite the inferior quality of their machines, as reported in the notes of the French diplomat in Batavia. These machines were cheaper than those of the French and English⁸⁷ but needed constant repair, leading to enormous outlay of money and time. Despite the entry of new competitors, the British continued to be the leading machinery manufacturers because of their access to natural resources and their industrial leadership and experience. Britain was followed by its ex-colony, United States of America, which had an enormous advantage in the Caribbean. The geographical proximity of the industrial East Coast would be one of the decisive factors in the United States' machinery trade because it facilitated rapid shipping and considerably lowered the cost of freight. However, for certain companies, these advantages did not necessarily ensure orders. *West Point Foundry* of New York conducted an enormous volume of business with Cuba but was apparently unable to -or did not want to- maintain it.⁸⁸ The *West Point Foundry* eventually lost an important portion of the market to other American companies, such as *Novelty Iron Works* and *Merrick & Towne Foundry*, or Scottish firms in Glasgow such as *McOnie* and *Mirlees*.⁸⁹ According to documents kept by Moses Taylor and collected by

⁸⁴ Jean-Jacques Ampère, *Promenade en Amérique : États-Unis, Cuba, Mexique*, vol. 2 (Paris: Michel Lévy frères, 1856), 141.

⁸⁵ Expédition dans les parties centrales de l'Amérique du Sud, de Rio de Janeiro a Lima Histoire du voyage, Vol V (1848), 204.

⁸⁶ Sugar machinery enter free-duty in Java. Consul Jouslain in Batavia, 1st october 1886. Agents diplomatiques, *Bulletin consulaire français : recueil des rapports commerciaux adressés au Ministère des affaires étrangères par les agents diplomatiques de France à l'étranger* (Paris: Imprimerie nationale, 1885), 135.

⁸⁷ Consul pointed that "les constructeurs anglais vendent leur machines au poids et visent à construire des marchines très Lourdes", Agents diplomatiques, *Bulletin consulaire français*, (1879), 310.

⁸⁸ Roland Ely, *Cuando reinaba su majestad el azúcar, Estudio histórico-sociológico de una tragedia latinoamericana, el monocultivo en Cuba: Origen evolución del proceso* (La Habana, Imagen Contemporánea, 2001).

⁸⁹ David Pretel, Nadia Fernandez-de-Pinedo, *Circuits of knowledge: foreign technology and transnational expertise in nineteenth-century Cuba*.

Roland T. Ely, *West Point Foundry* doubted the solvency of the Cuban plantations and therefore forced them to pay cash. If payments were made on credit, the buyer had to be evaluated by a reputable commercial company.⁹⁰ This suspicion and the company's lack of professionalism in altering the conditions of the contracts and not complying with delivery dates, made the American company lose prestige among the Cuban plantation owners. The example of the *West Point Foundry* confirms the importance of factors other than price or accessibility to the success of a company's product.

3.3. Advantages

To counteract these two disadvantages, high price and intense competition, *Derosne & Cail* had a medium- and long-term strategy based on the following elements.

3.3.1. Informal Communication Networks

One of the decisive factors for market success is the participation in innovation and merchant networks. Reiteration of actions over time allows networks to endure and be trusted over other weaker networks. Acting as a reassuring market,⁹¹ trust is a form of social capital that reduces transaction costs and influence on institutions.⁹² There must be a certain level of reliance between the firm, the agent and the receiver. Personal reputation and individual liability made some clients prefer *Derosne & Cail* to their competitors.

Prior to choosing which technology to adopt, it was usual, at least in the sugar sector, for governments, entrepreneurs or economic associations to review reports or memos, commissioning one or more individuals to collect the necessary information and help them make the best decision. Those buying machinery constructed their own information networks through direct contact. Cuba was integrated within this broad international technology network through the sugar oligarchy. This network connected the inventor or manufacturer directly to the sugar producer. This process is, at least, how *Derosne & Cail* came into contact with the Cuban planters. The two networks were overlapped.

In other words, it constituted a *shuttle network* where feedbacks between suppliers and consumers were constant. Not only was it necessary a good quality product, but also to create a brand community, which was achieved with a network connecting the manufacturer with the customer, and the technicians with the product, thereby enhancing product quality through continuous updates and improvements.

a) Sugar producers (Consumer)

⁹⁰ Ely, *Cuando reinaba su majestad el azúcar*, 517.

⁹¹ Beckert (2005), 6.

⁹² J. Coleman, *Foundations of Social Theory* (Cambridge, Mass: Harvard University Press, 1990) Putnam, *Making democracy work: civic tradition in modern Italy* (Princeton: Princeton University Press, 1993), Francis Fukuyama, *Trust: Social Virtues and the Creation of Prosperity* (NY: Free Press, 1995).

There are numerous examples that demonstrate the existence of this solid network of consumers.

The Spaniard Pedro José Triplana⁹³ was commissioned in Paris by the Council of Directors of the *Real Sociedad Económica de Amigos del País de Valencia* to confirm the improved performance of Derosne & Cail's products after the publication of Derosne's book in 1844.⁹⁴ They asked him to compare the company's products with other machines before recommending whether they should order from the French firm. Triplana visited many of the sugar machinery factories in northern France, traveling as far as Bordeaux; visited the workshops of *Derosne* and one of the company's factories in the Antilles; collected information from sugar manufacturers, foremen, and workers; and even visited members of the French Academy of Sciences (Dumas and Payen). He also exchanged letters, between 1843 and 1845, with planters in the Antilles, in Trinidad and Havana with Mangeon, Justo G. Cantero, Ayestarán, Lefrane, Arrieta, and Villaurrutia. He finally recommended the French company because of the satisfaction he observed among the sugar makers who had already installed their machines and because "the good reputation, science and practice, the capital and the social position of the company itself elevate it to a sufficient level for it to monopolize, as in fact it does monopolize in a certain sense, when it comes to the sugar industry, constantly making small improvements, taking advantage of others, and communicating this with industrialists in the area".⁹⁵

The innumerable technical advances being made in the sugar sector arrived in Cuba through various news channels and other lines of communication. The *Sociedad Económica* gave prizes for information that it thought would advance the sugar industry, and many reports were published partially or in their entirety in the island's periodicals (*Faro Industrial*, *Semana Literaria*, *Diario de la Marina*, etc.). Whenever a report was issued about a new advance that could be implemented in Cuba, the *Junta de Fomento* organized a commission to evaluate it. The *Junta de Fomento*, in 1842, assigned the chemist and planter José Luis de Casaseca the task of examining the progress being made in sugar-refining processes in foreign countries. To fulfill his task, Casaseca examined and compiled treatises, pamphlets and maps of the methods employed in England, France, Belgium and Austria, among others.⁹⁶ Casaseca submitted a 59-page report, approved by the Institute of France in 1844, in which he expressed partiality for the system invented by Charles Derosne.

b) Sugar Machinery Manufacturer (Supplier)

Derosne took advantage of the need for access to accurate and trustworthy information by creating his own network of contacts with technology consumers, especially those in

⁹³ Triplana, *Empresa azucarera peninsular con privilegio exclusivo [sic] de introducción*. Pedro José Triplana was a Law Graduate from Granada University, who has obtained the academic qualification of lawyer "de los Reales Consejos" and has a good position as judge in Málaga. *Eco del Comercio*, Madrid, 25/03/1835 (329), 1.

⁹⁴ Charles Derosne; Jean-François Cail, *De la Fabrication du Sucre aux Colonies et des nouveaux appareils propres et améliorer cette fabrication* (Paris: Bouchard-Huzard, 1844).

⁹⁵ Triplana, *Empresa azucarera peninsular con privilegio exclusivo [sic] de introducción*, 15.

⁹⁶ ANC, Junta de Fomento de la Isla de Cuba, Negociado de Agricultura legajo 95, exp. 4040 y legajo 205, exp. 9115.

the colonial markets. This network provided feedback as it been set out. The strategy was simple and consisted of persuading a large landowner or planter to install its vacuum pan and construct modern factories. The first test of this strategy occurred on the island of Réunion in 1838. After the factory became operational and the first harvest was gathered, the other planters on the island were invited to visit the installations, where they were convinced of the excellence and advantages of this new process. The same strategy was implemented in Cuba. Beginning in 1830, Derosne maintained contact with several planters based in Cuba who were in touch with the interests of entrepreneurs and local authorities to ensure the success of this branch of the industry. In 1843, three planters installed equipment in their mills with assistance from Derosne himself.⁹⁷ According to a report by Ramón de la Sagra, Wenceslao Villaurrutia installed a partial apparatus for boiling and concentrating molasses in 1840⁹⁸ before purchasing a complete system. According to the United States Patent Office, the Derosne installation purchased by Villaurrutia cost \$32,000.⁹⁹ Derosne himself also trained Villaurrutia's technicians to use the new innovation and supervised its installation on the other Cuban plantations. The presence of the manufacturer was decisive, as the 1841 and 1842 results demonstrate. Villaurrutia also installed complete apparatuses for a new system in his Bolumbre mill in 1843; the order was made in Paris through the Aguirrevengoa sons and Urribarren, the Spanish intermediaries of the company located there.¹⁰⁰ On November 27, 1843, the *Diario de la Habana* reported that the *Junta de Fomento* had accepted Villaurrutia's report of the good results already obtained from that year's harvest at the mill.¹⁰¹ Villaurrutia also requested a loan of 9,000 pesos to complete the installation, the effect of which was presented in a report of the 1843 harvest, which had been processed using the Derosne equipment. The loan was granted.¹⁰² In 1842, Justo Cantero¹⁰³ ordered another apparatus from Derosne & Cail in Paris, which was installed the following year at his mill in Güinía de Soto. In 1852, he placed another order for 4 centrifuges from Cail & Cie. The third planter was Joaquín de Arrieta, who installed a Derosne apparatus at his Flor de Cuba mill in 1843. On this occasion, the *Junta de Fomento* organized a

⁹⁷ Ramón de la Sagra, *Cuba en 1860, Selección de artículos sobre agricultura cubana*, (La Habana: Comisión Nacional Cubana de la UNESCO, 1963) 82; Manuel Moreno Fraginals, *El ingenio, Complejo económico-social cubano del azúcar* (La Habana: Editorial Ciencias Sociales, 1978), Vol. 3, 161; Carlos Venegas: «El libro de los ingenios», in A. Malpica (ed.): *Agua, trabajo y azúcar* (Granada: Diputación Provincial, 1996), 91.

⁹⁸ The proliferation of Derosne apparatus was due to “la inteligencia y perseverancia, y á los grandes medios, así en lo personal como en lo material, de que podia disponer su casa”. Ramón de la Sagra y Peris, *Historia física, política y natural de la isla de Cuba*, vol. XIII, (1861), 85.

⁹⁹ “Annual Report of the Commissioner of Patents for the Year 1848”, *United States Patent Office* (Washington, 1849): 328

¹⁰⁰ Guicharnaud-Tollis, *L'équipage Derosbe en Guadeloupe et Cuba au XIXème siècle*, 131.

¹⁰¹ ANC Junta de Fomento de la Isla de Cuba .Negociado de Agricultura, Legajo 95, exp 4006; legajo 170, exp. 8101.

¹⁰² ANC. Junta de Fomento. Negociado de Cuentas. Legajo 41, n° 1824, 31 marzo 1842, n° expediente 4086 y Legajo 41, exp. 2576.

¹⁰³ Justo Germán Cantero, *Los Ingenios: Colección de vistas de los principales ingenios de azúcar de la Isla de Cuba*, ed. Luís Miguel García Mora y Antonio Santamaría García (CSIC-Dpto. de Publicaciones, 2005), 136-137.

commission¹⁰⁴ to inspect and collect information about the harvest processed with the new equipment.¹⁰⁵

The experiences of these first three pioneers required them to report the results of their respective harvests and to allow other planters to inspect their mills. As a result, the company's equipment became popular in Cuba. In 1847, the Zulueta mill was already running two of Derosne's apparatuses¹⁰⁶ and also installed the modern apparatus for vacuum evaporation and the triple effect apparatus presented by *Cail & Cie* at the Universal Exposition in 1863. The data collected by La Sagra, Rebello and Cantero also confirmed the charcoal savings and other advantages of Derosne & Cail's apparatus over previous systems.¹⁰⁷

3.3.2. Product Differentiation

a) Marketing: direct and indirect advertising

The company itself received some publicity through specialized magazines and other media, such as the periodicals *L'Ostre-mer* and *Publication Industrielle*.¹⁰⁸ Especially useful was the publication in Paris of the company's book *De la fabrication du sucre aux colonies* in 1841, which solidified its fame and good reputation and firmly established the trademark of *Derosne & Cail* in the sugar industry. Derosne's book was translated in Cuba by the chemist José Luis Casaseca. Four copies were deposited in the public library in Havana, and 500 copies were distributed to planters.

However, the most effective and beneficial advertising was indirect and came through exhibitions, first French and then international. These exhibitions provided a convenient platform for advertising the achievements of *Derosne & Cail*. They attended all of the French exhibitions beginning in 1819 and the first universal exhibition in London and Paris and those that followed. The company received immense recognition at these exhibitions and, between 1819 and 1885, won 64 prizes (gold medals, silver medals, medals of honour, medals of merit, grand prizes, diplomas of honor, etc.). It was even co-decorated with the *Légion d'honneur* in July 1844.

In addition to the medals, they received significant attention from the specialized magazines that reported on these exhibitions and exalted the manufacturers that presented there, including the *Rapport sur l'Exposition publique des produits de l'industrie française* (1844); *Revue générale illustrée des trois expositions de Paris, Besançon et*

¹⁰⁴ANC, Junta de Fomento de la Isla de Cuba. Negociado de Agricultura, Legajo 95, exp. 4761 y Legajo 170, exp. 8101, *Expediente informe del Sr Villa Urrutia sobre el tren de azúcar de Derosne* (1843).

¹⁰⁵ANC, Junta de Fomento de la Isla de Cuba. Negociado de Agricultura Legajo 95, exp 4006, *Expediente sobre nombramiento de una comisión que inspeccione el tren de elaborar azúcar de Derosne establecido en el Ingenio del Sr Joaquín de Arrieta* (1843).

¹⁰⁶Letter dated in La Habana, 4th July 1847. A. E., Paris, CCC, La Havane, vol. 15, f. 99.

¹⁰⁷Ramón de la Sagra y Peris, *Historia física, política y natural de la isla de Cuba*, vol. XIII, (1861), 85.

¹⁰⁸*Commercial Review of the South and Est* edited by J.D.B. De Bow, Vol. VII, New Series, Vol. I, July-December 1849, Art. II- Manufacture of Sugar, 121.

Montpellier (1860); and *Les nouvelles inventions aux Expositions universelles* (1858). This type of indirect advertisement was highly beneficial.¹⁰⁹

b) The Derosne reputation

During this first phase of the company's expansion in the 1830's and 1840's, acquiring Derosne machinery meant not only that the maker-inventor himself would travel to assemble the equipment but also that he would be accompanied by a team of engineers whose duties were to assemble the apparatus and train the individuals who would be in charge of the new installations. Charles Derosne himself traveled overseas to the Caribbean and Southeast Asia, not only because the complexity of the machinery required it but also to generate confidence among planters in his company's product. A product which was expensive and had to be acquired, imported and installed. The French entrepreneur did not hesitate to travel to Cuba in 1841, 1842 and 1843 to personally install his apparatuses at the first mills that ordered his machinery and to introduce it to this new market. He made his final trip to Cuba at age 68,¹¹⁰ exactly one year before his death.

Every installation required "an important presence of foreign technicians and workers, as well as the importation of very different machinery, and the intervention of people with information and very precise knowledge regarding the alternative techniques existing in industrial Europe and their possibilities for application in the region."¹¹¹ One of the major problems in the colonies was the scarcity of qualified mechanics who could assemble and repair the apparatus. Acquiring replacement parts was also difficult. Because there were no schools to provide technical training, which hindered the importation of technology, the company itself provided and transmitted the specialized technical knowledge. After the experiment in Réunion in the 1840s, Derosne's company continued to guarantee assistance with its equipment, both at the time of assembly and when it was put into operation by the planters. He also offered post-sale technical service by supplying European engineers, mechanics and technicians.¹¹²

¹⁰⁹ *Le Génie industriel : revue des inventions françaises et étrangères : annales des progrès de l'industrie agricole et manufacturière*; *Gazette de l'industrie et du commerce*; *Mémorial du commerce du commerce et de l'industrie, répertoire universel, théorique et pratique, législatif et judiciaire, de la science commerciale*. In the reports of the Societies as the *Journal of the Royal Agriculture & commercial Society of Guiana*, *Memorias de la Sociedad Económica de Amigos del País de la Habana* ... or in specialized handbooks as *Traité de Chimie Industrielle*; *Nouveau traité de chimie industrielle à l'usage des chimistes* (1879); *Publication industrielle des machines, outils et appareils les plus perfectionnés et les plus récents employés dans les différentes branches de l'industrie française et étrangère* (184-1890); *Les merveilles de la science ou Description populaire des inventions modernes* (1867-1891).

¹¹⁰ «L'île de Cuba, ses ressources et le développement possible de ses relations avec la France», *Journal des économistes : revue mensuelle de l'économie politique, des questions agricoles, manufacturières et commerciales*, (Paris: Librairie Guillaume et Cie., 1898), 79.

¹¹¹ Emiliano Fernández de Pinedo y Rafael Uriarte Ayo, «La siderurgia: cambio técnico y geografía industrial», en *Técnica e ingeniería en España VII. El Ochocientos. De las profundidades a las alturas*, ed. Manuel Silva Suárez, vol. VII, *Técnica e Ingeniería en España* (Prensas de la UZ/Real Academia de Ingenieros/IFC, 2013), 204.

¹¹² Galloway, *The Sugar Cane Industry, An Historical Geography from its Origins to 1914* (Cambridge: Cambridge Studies in Historical Geography, 1989), 157.

Trust in the French company, then, was not only fostered by the quality of the product that it sold but by the healthy reputation of its founder and the skilled workforce that the firm deployed.¹¹³ This situation explains why *Derosne & Cail's* competitor in Cuba, Norbert Rillieux,¹¹⁴ who was born in New Orleans and resided in France (where he obtained a patent in 1843 and a “brevet de perfectionnement” in December 1846¹¹⁵), did not acquire greater renown. As Roland T. Ely noted, although Rillieux’s equipment was cheaper and even performed better, it did not achieve the fame Derosne’s products did and was therefore less frequently installed.¹¹⁶ Following his strategy of forming alliances, Rillieux began working for Cail & Cie upon Derosne’s death.

Providing the planters with technical expertise was a decisive factor, according to Ramón de La Sagra, in the rapid increase in orders in the following decade.¹¹⁷

c) Finance & Credit

The purchase of this type of machinery had several implications, as we have seen, including dependence on skilled labor and a heavy financial commitment. Lack of financing was a constant problem in the colonies. Tomich notes that in the French West Indies, $\frac{3}{4}$ of the planters in the 1840’s “were indebted for sums equivalent to half and sometimes the entirety of the value of their real and moveable property.”¹¹⁸ Therefore, only a minority adopted new techniques, not because they were not effective, but because they were costly and entailed many indirect consequences.¹¹⁹ As Roland T. Ely notes, Cuban “planters, in their rush to modernize, had bled themselves dry financially.”¹²⁰ The *Estado de la Industria Azucarera en la Isla de Cuba en 1860* prepared by Ramón de la Sagra,¹²¹ reveals that only 51 planters used vacuum pans, whereas 1314 continued to use Jamaican Train. In addition to vacuum pans, centrifuges were also installed, which enhance financial problems because the increasingly complex equipment was also more expensive. Between 1850 and 1857, planters imported a total value of 238,631,057 pesos reales in equipment.¹²²

¹¹³ Adrian B. Leonard and David Pretel, *Experiments in modernity: the making of the Atlantic World economy*, in Leonard & Pretel (eds.) Leonard, A. & Pretel D. (eds), *The Caribbean and the Atlantic World economy: circuits of trade, money and knowledge, 1650-1914* (London:Palgrave-McMillan 2015).

¹¹⁴ Rillieux first worked for Merrick & Towne.

¹¹⁵ *Le Génie industriel. Revue des inventions françaises et étrangères, annales des progrès de l'industrie agricole et manufacturière*, (Paris, 1852), Vol. 3, 11.

¹¹⁶ Ely, *Cuando reinaba su majestad el azúcar*, 537.

¹¹⁷ Ramón de la Sagra y Peris, *Historia física, política y natural de la isla de Cuba*, (Paris: Arthur Bertrand, 1855) Vol. 13, 83.

¹¹⁸ Dale Tomich, «Sugar technology and slave labor in Martinique, 1830-1848», *New west Indian Guide /Nieuwe West-Indische Gids* (1989) (63 1/2): 121.

¹¹⁹ “To extract maximum value from their machines, planters needed to exploit additional land and purchase even field slaves”. José Guadalupe Ortega, *The Cuban Sugar Complex in the Age of Revolution, 1789-1844*, (ProQuest, 2007): 202.

¹²⁰ Ely, *Cuando reinaba su majestad el azúcar*, 536.

¹²¹ Ramón de la Sagra y Peris, *Historia física, política y natural de la isla de Cuba*, Vol. 13,105.

¹²² Balanzas del comercio de Cuba 1850 a 1857. Nadia Fernandez-de-Pinedo, *Comercio exterior y fiscalidad en Cuba* (Bilbao: UPV, 2001).

The period between 1840 and 1860 saw the appearance of the merchant- *refaccionistas*,¹²³ some of whom were foreigners, who dedicated themselves to anticipating the capital necessary for modernization and helped planters to commercialize their products, making enormous profits. Foreign firms also arrived during this period, including *Moses Taylor* of New York and the *Baring Brothers* of London, to open lines of credit in Cuba. The problem of capital in Cuba has been explored by Moreno Friginals, who stated that in the 1860s, 93% of the industry had taken out mortgage loans.¹²⁴ After the Ten Years War in the 1880s, small mills in eastern Cuba were disappearing. Simultaneously, the industry was being concentrated and centralized in the hands of powerful families. Zulueta, Terry, Baró, Apertegui, Montalvo, and Moré were among those whose capital was amassed through the export of sugar and the slave trade.¹²⁵

Because the company's sugar equipment and machinery was expensive and planters often had difficulty finding financing, *Cail* provided industrial and financial assistance to make the company attractive to a larger portion of the market and to differentiate itself from its competitors.¹²⁶ The company invested in, directed and contributed to the creation of the Raffineries Lefranc in Tracy, the Sucrerie in Méru, the Sucrerie in Meaux, 4 factories in Guadalupe, and 7 in Martinique, and built 16 factories in Guadalupe and 11 in Martinique between 1844 and 1880.¹²⁷ Cail, aware of the need for credit in the French colonies, proposed to Napoleón III in 1860 the creation of the *Crédit Colonial* to provide long-term financing for modern central factories or improvements to those that already existed. In Cuba, Derosne gave planters a discount of 25% and allowed customers to pay in two installments. He allowed an extra year for the payment of half of the cost of the vacuum pans,¹²⁸ which contributed to the adoption of Derosne's equipment in the island.

The high demand for machinery also meant that there was a proliferation of “nombreuses maison de commission qui forment les intermédiaires financiers ordinaires du commerce de Maurice, et des demandes importantes passant par Londres arrivèrent à la maison Cail”¹²⁹ in the colonies.

It is true that the French company was successful in the Cuban market, but those who adopted the most advanced machinery were the wealthiest planters¹³⁰ -Zulueta and Parejo had profited from the slave trade- because of the significant expense of modernizing. The

¹²³ Enrique Collazo Pérez, “Empresarios Asturianos En Cuba (1840-1920)”, *Revista de Indias*, vol. LXII, núm. 225, (2002): 548.

¹²⁴ Moreno Friginals, *La historia como arma y otros ensayos sobre esclavos, ingenios y plantaciones* (Barcelona: Crítica, 1983), 73. See also Francisco Comín, Ángel Martínez Soto e Inés Roldán de Montaud, *Las cajas de ahorros de las provincias de Ultramar, 1840-1898. Cuba y Puerto Rico*, (Madrid: Funcas, 2010).

¹²⁵ Fe Iglesias García, *Del ingenio al central* (La Editorial, UPR, 1998).

¹²⁶ “livraison à crédits des équipements, fourniture de fonds de roulement, prose de participation dans les usines”, Thomas Jean-Louis, *Jean-François Cail. Un acteur majeur de la Révolution Industrielle*.

¹²⁷ « Cette création (...) amène l'investissement de capitaux français et martiniquais pour la construction des usines. Parmi ces investisseurs métropolitains se trouve donc JF Cail qui, en une dizaine d'années, va devenir le premier financier et le plus gros producteur de sucre des Antilles» *Association C.A.I.L. (2004)*, 59 and 167-205.

¹²⁸ *El Heraldo de Madrid*, 14/7/1849, 4.

¹²⁹ Turgan, *Les grandes usines, études industrielles en France et à l'étranger*,

¹³⁰ “The excellent but rather expensive apparatus of Derosne and Cail, they understood was about to be introduced on one of two largest estates, whose proprietors were in a position to bear the outlay”. Two Years of the “Society”, *Timehri Being. The Journal of the Royal agricultural & commercial society of Brisith Guiana*, 1893, 222. See also Ely, *Cuando reinaba su majestad el azúcar*, 541.

reports of the *Royal Agricultural and Commercial Society of British Guiana* noted in the 1840s that “the excellent but rather expensive apparatus of Derosne and Cail, they understood was about to be introduced on one of two large estates, whose proprietors were in a position to bear the outlay.”¹³¹

d) Continual upgrading of incremental innovations

Continuous innovation¹³² or the ability to adapt to the needs of consumers through three different channels created an advantage for the company.

In the nineteenth century, it was crucial for companies to remain competitive and not fall into obsolescence. As noted by Ortega, *Derosne & Cail*, because of the connections and networks it had established with landowners and planters, was able to introduce changes relatively quickly when customers reported problems, made suggestions or simply commented on manufacturing details. An apparatus assembled in Paris did not have the same problems as one assembled in Cuba. Many planters were aware of the products’ problems and of possible improvements. One significant channel of information for the firm were the planters themselves. Unsurprisingly, patent records show that those who applied for patents for new inventions in Cuba not infrequently were sometimes the planters themselves or mill workers who were attempting, through micro-inventions or improvements, to perfect the process of refining sugar and its derivatives. Derosne’s and later Cail’s visits to the plantations had a double purpose: to generate trust and to collect information that could be used to make improvements to their equipment. It was a bidirectional network.

On the other hand, the company had a *Bureau d’Études*, a Research and Development Department, whose first director was J. Houel. Engineers and those educated in *Arts et Métiers*, such as Charles Martin, Paul Jardillier, Antoine Montigny, Isidore March Rémy, and Albert Vanier, were appointed *chef des études* at some of the company’s branches, developing innovations in locomotives, sugar factories and distilleries.¹³³ Many of the individuals who first received diplomas in *Arts et Métiers* (Angers, Paris, Châlons, Aix) eventually acquired the title of engineer after engaging in practical work at the company for many years. The company also trained the chemists that it needed in its own factories. The president of the Chemical Society of Paris mentioned the need to recruit the chemists trained in great industrial companies such as the *Société Cail* to teach at the *École de Pharmacie* and *École Centrale des Arts et Manufactures*, where industrial chemistry was particularly important. Their expertise could be used to decrease the competitiveness of foreign products.¹³⁴

¹³¹ «The First Two Years of the “Society”», *Timehri Being. The Journal of the Royal agricultural & commercial society of British Guiana* (1893), 222. See also David Pretel and Nadia Fernandez-de-Pinedo, *Circuits of knowledge: foreign technology and transnational expertise in nineteenth-century Cuba*.

¹³² Jose Guadalupe Ortega, *The Cuban Sugar Complex in the Age of Revolution, 1789--1844* (ProQuest, 2007), 200.

¹³³ www.patronsdefrance.fr/ (Seen the 22th february, 2014).

¹³⁴ E. Noellting y Ausguste Dollfus, *De la nécessité de la création d’une grande école de chimie pratique et industrielle, sous le patronage de la Société chimique de Paris* (Paris: P. Dupont, 1891), 11.

These well-known professionals never lacked for work. Mobility was usual and often necessary to achieve success. Cuba was also in need of skilled labor. According to Rossignon, machinists and mechanics were, with refiners, receiving the highest salaries (900 pesos), followed by carpenters (800) and foremen (700).¹³⁵ Jean-Baptiste Supervielle was one of these *ouvrier mécanicien* who worked at the *Cail* agency in Havana. He was among those assigned to assemble the firm's equipment in the mills. After arriving in Cuba, he formed a partnership with a planter and became joint director of a mill.¹³⁶ French consuls in Cuba emphasized that French workers from *Cail*'s company had earned considerable sums of money in the mills by adapting and repairing the machinery that had been installed.¹³⁷ In 1881, a French diplomat observed that in Argentina alone, this work generated approximately 20 million francs during the 1870s.¹³⁸

In addition to training professionals, skilled workers and profited from planter's feedback, the company continued to follow the example of its founder, Derosne, in constantly improving its equipment through collaboration with other inventors. Its good reputation was based in part on knowing how to forge alliances with other inventors. The publication *Le Génie Industrielle* emphasized in 1866 that this collaborative activity was key to the company's success: "sachant s'allier des hommes capables, intelligents, travailleurs, et en recherchant les meilleurs inventions susceptibles d'apporter un avantage réel dans les procédés de fabrication." The author cites the case of the German inventor, M. Penzoldt, for whom the company "fait depuis pension de 1200 francs."¹³⁹ This collaboration had remained in place since its beginnings with Cellier-Blumenthal, Champonnais, and Rillieux.

Once knowledge and skills were consolidated, it was necessary to expand the business. The company distributed agents across the globe. In most cases, these agents were its own mechanics and engineers,¹⁴⁰ who assumed responsibility for and oversaw the operation of the installed equipment. In fact, much of the company's business consisted of regularly providing the replacement tools that the equipment required. Indeed, this activity motivated the early establishment of warehouses and agents. However, Derosne & Cail's employees were not the only agents. The relationship between Derosne & Cail and the planters led them to appoint several planters as its Cuban business partners. Documents held in the National Archive of Cuba show that Wenceslao Villaurrutia, Joaquin de Arrieta and Pedro Lefranc all served as agents. In June 1842, Joaquin de Arrieta, acting as agent, representative for Derosne & Cail, requested a 15-year exclusive right to a new system for producing¹⁴¹ sugar. The *Junta de Fomento* denied the request on June 20,

¹³⁵ Jules Rossignon, *Manual del cultivo de la caña de azúcar* (París, 1859), 192.

¹³⁶ www.patronsdefrance.fr/ (Seen the 22th february, 2014).

¹³⁷ A Agents diplomatiques, *Bulletin consulaire français : recueil des rapports commerciaux adressés au Ministère des affaires étrangères par les agents diplomatiques de France à l'étranger* (Paris: Imprimerie nationale, 1885), 130 and Agents diplomatiques, *Bulletin consulaire français* (Paris: Imprimerie nationale, 1888), 161.

¹³⁸ R. Wagner, Consul of France in Buenos Aires, 20th of june 1882. Agents diplomatiques, *Bulletin consulaire français* (1882), 196.

¹³⁹ *Le Génie Industrielle*, Tome 31 (1866), 243.

¹⁴⁰ Stievenard Charles from *Établissements Cail*, was in charge of installing Centrals in the colonies. www.patronsdefrance.fr/ (Seen the 22th february, 2014).

¹⁴¹ ANC. Secretaria Superior Civil, junio 1842, legajo 1475, expediente 58365.

1843, stating that the system was already installed on the Island. It also mentioned the Royal Document on invention rights and the introduction of foreign machinery, which had arrived in August 1836.¹⁴² Wenceslao Villaurrutia also represented Derosne in Cuba when, in 1843, he requested a right to manufacture, use and sell artificial charcoal of his invention as a replacement or substitute for animal charcoal in its various applications, a privilege that was granted for 10 years in October 1853. Villaurrutia or a representative was permitted to use and sell artificial charcoal. Planter Pedro Lefranc also requested, in the name of Derosne & Cail, the rights to an apparatus for crystallizing and purging cane in 1846. This request was denied.¹⁴³ These three men were not the only agents: Eduarde Laplante, a lithographer and commercial agent based in Cuba beginning in 1848, was also a representative for Derosne & Cail.¹⁴⁴

In addition, requests and replacements could be made through various agents, including the *Société Durège, Ducrey et Cie*, which was located in Havana between 1855 and 1870. Daniel Ducrey was one of *Cail & Cie*'s most reputed engineers and assembled Derosne apparatus in Cuba for the Santa Susana Mill of Antonio Parejo; the San Martín Mill of Francisca Pedrosa y Herrera; and the Ácana Mill of J. Eusebio Alfonso.¹⁴⁵ The partnership was created expressly for the purpose of buying and selling *Derosne & Cail*'s manufactured products, machines and apparatus in Cuba.¹⁴⁶

4. Conclusions

This article shows that MNE were a relevant channel for the international transfer of knowledge and technology to peripheral economies such as Cuba between 1830 and 1880; even if this transfer was partial and incomplete due to the lack of "social capability" of Cuban economy to absorb advanced technologies, as pointed out by Abramovitz. By exploring the operations of this multinational corporation during the mid-19th century, this case study should make us reconsider the origin of modern multinationals, an overturn/invalid the argument that these type of business organizations had their origin during the Second Industrial Revolution.

The *Derosne & Cail* case study provides an example of a global and adaptive company through the transnational operations of sugar machinery. One of the consequences of first industrial revolution was the great competition between firms connected with the steam machines. This competition forced companies in early times to follow different strategies such as internationalization, diversification, foreign direct investment, R&D. ...and transform some of these firms in modern multinationals before 1850, furthermore, before the spread of the so-called Big Business feature of the second industrial revolution.

It was during the years of the first industrial revolution when socio-technical networks started to play an increasing role in the globalization of technological knowledge,

¹⁴² ANC. Junta de Fomento. 1 julio 1842. Legajo 205, n° 9115, expediente. 4153.

¹⁴³ Legajo 206, exp. 9172, *Expediente sobre privilegio solicitado por D. Pedro Lefranc en nombre de los Sres Derosne y Cail para un aparato de cristalizar y purgar la caña* (1846).

¹⁴⁴ Justo G. Cantero, *Los Ingenios*, 65.

¹⁴⁵ Justo G. Cantero, *Los Ingenios*, 191, 195, 287.

¹⁴⁶ The Company was formed on August 9th 1855 "suivant acte passé devant Mr. Achille Descours, notair à Paris" until May 21th 1870, with a capital of 2,000,000 francs divided into 4,000 shares of 500 francs each. *Gazette de l'Industrie*, (8/06/1855, Paris): 5.

machinery and innovation processes.¹⁴⁷ The role of the first multinationals turned to be relevant in the transfer of technology, while contributing to the intensification of expert migration. In a period of accelerated capitalist globalization, foreign engineering firms began to dominate the trade in modern industrial technologies and were responsible of networks and circuits of technological exchange.

This transfer in the Atlantic world economy can be explained as the result of a global economy. The Derosne & Cail case study provides an example of how important was the circulation of transnational expertise during the mid-nineteenth century and before. In fact, foreign firms took advantage of the lack of skilled labor that was one of the biggest problems of the transfer because non-technical education adapted to the new technology delved deeper into foreign dependency.

Derosne & Cail ensured its success not only by increasing the volume of the business it conducted in its home country (Paris, Douai, Denain, Valenciennes)¹⁴⁸ but also by expanding to new markets (Holland, Belgium, Russia, the Caribbean, Southeast Asia).¹⁴⁹ This expansion led the company to create branches outside of France beginning in the 1830s. Instead of exporting and seeking new markets, it invested directly in other regions. This expansion was made possible through the company's technological advantages, organizational advantages and the good reputation of its trademark, which was supported by the quality of its products. Derosne & Cail therefore employed a strategy typical of nineteenth-century entrepreneurs, beginning as manufacturers of machines and equipment for sugar processing and distillation and eventually becoming "le plus grand établissement qui existe peut-être en Europe"¹⁵⁰ and a multinational¹⁵¹ company whose headquarters exerted great control.

To accomplish this goal, the company began to diversify its production soon after its establishment. From its beginnings in the sugar sector, it expanded to railroads and began manufacturing presses for producing currency and artillery. It used its technology-based resources,¹⁵² including steam, chemistry, and engineering, to retain its market share and form strategic alliances with other manufacturers, inventors and competitors. The manufacture of equipment for refineries and sugar factories continued to be, at least in the nineteenth century, its most successful business after locomotives.

Derosne & Cail also offered intangibles, such as innovative products, recognized systems of marketing and organization and human capital, all of which were supported by the quality of its products and the company's reputation. First, it established a solid reputation

¹⁴⁷ David Pretel, Nadia Fernandez-de-Pinedo, *Circuits of knowledge: foreign technology and transnational expertise in nineteenth-century Cuba*.

¹⁴⁸ "Cette entreprise, qui avait essaimé d'autres maisons à Lille, Douai, Bruxelles et Amsterdam, et avait créé des raffineries jusqu'à Java, employait, en 1848, 2 000 ouvriers à Paris ». Rémi Gossez « Comité international permanent », in *Revue des révolutions contemporaines*, n° 189, (1951): 97-11.

¹⁴⁹ Raymond Vernon, «The Product cycle hypothesis in a new international environment», *Oxford Bulletin of Economics & Statistics* 41, n° 4 (1979): 255-267.

¹⁵⁰ *Le Génie Industrielle*, Tome 3 (1866): 243.

¹⁵¹ According to Buckley (2006), 678: "there is a crucial relationship between the firms's size and overall market size".

¹⁵² "From the mid-nineteenth century, science became the measure of all progress. The progress of knowledge, as well as technical and social progress, were directly assimilated to the progress of science". (PetitJean, 2005, 112).

through merchant and innovative networks that convinced the sugar producers of the short-term economic benefits of installing its equipment. The international reputation the company had earned in Europe guaranteed its product and allowed it to expand to other countries. Second, the most advanced sugar technology in the mid-nineteenth century was developed in the sugar beet sector. Sugar processing became increasingly complex, requiring more specialized technology and thus skilled engineers and repair shops. Landowners' continual complaints about the lack of skilled labor and technical schools were doubtless taken advantage of by *Derosne & Cail* and other machinery manufacturers, who soon began to offer this service.

This new technology was expensive, and the principal manufacturers were found in England and the United States. Nevertheless, the company of *Derosne & Cail* managed to convince 33 of the 77 mechanized sugar mills in Cuba in 1860 to install its vacuum apparatus.¹⁵³ Though its product was more expensive than its competitors', the French company enjoyed a positive reputation, in part because it not only provided equipment but also guaranteed technical assistance with assembly and operation. During this process, it trained technicians who could keep the machines functioning or trained skilled workers in its shops who could then find work in these markets. Summing up, the strategy of the French firm was based on a reputed brand, quality products and service, formal and informal networks through branches and agents.

But, what really seems essential was the role of the feedback shuttle networks before 1850. Those networks provided the necessary amount of information in order to satisfy the demand, thereby enhancing product quality through continuous updates and improvements. The key was a perfect feedback system.

In our opinion, a new path for research has been opened, as the current study demonstrates the existence of "modern" French MNEs in the eve of 19th century that had in part been overlooked by the specialists up to now. Thus, in the near future, a study needs to be undertaken within an historical and comparative perspective of the rise and influence of Big Business during the first industrial revolution.¹⁵⁴ Only in this manner shall a correct overview be obtained of how knowledge crossed borders and oceans from the beginning of the 19th century onwards. And only in this manner will its evolution in time be understood.

¹⁵³ Charles Rebello, *Estados relativos a la producción azucarera de la isla de Cuba: formados competentemente y con autorización de la Intendencia de ejército y hacienda* (1860).

¹⁵⁴ Youssef Cassis, *Big Business: The European Experience in the Twentieth Century*, (Oxford: OUP, 2003), 176.